

## IUTAM Symposium on “Dynamical Analysis of Multibody Systems with Design Uncertainties”

**Preface**

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A common problem in the analysis of mechanical systems is the fact that the parameters of the models can exhibit a high level of uncertainty and exact values for their quantification can often not be provided. This non-determinism in numerical models may arise as a consequence of different sources. On the one hand, there may be natural variability or scatter. On the other hand, there may be uncertainties which arise from a lack of information, e.g. for parameters to be still defined during the design phase of a product, but also from simplification and idealization as it usually appears in every modeling procedure. These conditions manifest as uncertain model parameters, and consequently, the results that are obtained for analyses of systems that only use one specific set of values as the most appropriate ones for the design parameters cannot be considered as reliable, since they are not representative of the whole spectrum of possible model configurations. For these reasons, various approaches to the inclusion of uncertainties in the numerical analysis of dynamical systems and structures have been introduced in the past decades, involving probabilistic as well as non-probabilistic techniques. Supported by the increasing capabilities of modern high-performance computing, these advanced, non-deterministic approaches to the dynamical analysis of mechanical systems are able to strengthen the trustworthiness of numerical predictions and to provide new possibilities in the processes of product development, such as engineering design and virtual prototyping, beyond the means of conventional, deterministic concepts.

Against this background, the aim of this IUTAM Symposium on “Dynamical Analysis of Multibody Systems with Design Uncertainties” was to give a state of the art of the potentials, challenges and limitations of different approaches to the analysis of mechanical systems in the presence of design uncertainties, and to present and discuss new developments, strategies and ideas.

The Symposium took place at the University of Stuttgart, Campus Vaihingen, in Stuttgart, Germany, from June 10 to June 13, 2014, and was hosted by the Institute of Engineering and Computational Mechanics. It continued a series of former IUTAM Symposia related to the inclusion of uncertainties in mechanical systems, such as

- the IUTAM Symposium on “Dynamics of Nonlinear Systems with Uncertainty”, Nanjing, China, 2006,
- the IUTAM Symposium on “Vibration Analysis of Structures with Uncertainties”, St. Petersburg, Russia, 2009, and
- the IUTAM Symposium on “Multiscale Problems in Stochastic Mechanics”, Karlsruhe, Germany, 2012.

But also at the hosting institution, the Institute of Engineering and Computational Mechanics, this IUTAM Symposium nicely resumed the tradition of IUTAM Symposia, as this was the fourth IUTAM Symposium hosted by this institute after

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- the IUTAM Symposium on “Nonlinear Dynamics in Engineering Systems” in 1989,
- the IUTAM Symposium on “Optimization of Mechanical Systems” in 1995, and
- the IUTAM Symposium on “Multiscale Problems in Multibody System Contacts” in 2006.

The IUTAM Symposium on “Dynamical Analysis of Multibody Systems with Design Uncertainties” was supervised by the following international Scientific Committee: Michael Hanss (Germany – Chairman), Alexander Belyaev (Russia), Harry Dankowicz (USA), Wim Desmet (Belgium), Haiyan Hu (China), Robin Langley (United Kingdom), Christian Soize (France), and Peter Eberhard (Germany – IUTAM Representative).

From the abstracts submitted for the Symposium, 24 papers had been selected for oral presentation. Due to uncontrollable circumstances, however, 4 scientists could not give their talks, i.e. 20 presentations were finally given at the Symposium. Each presentation was scheduled to 30 minutes in length, followed by 10 minutes for questions and discussion. The detailed scientific program of the Symposium was as follows:

#### Monday, June 9, 2014

18:00 - 20:00 Pre-Registration and Welcome Reception

#### Tuesday, June 10, 2014

9:00 - 9:50 Registration

9:50 - 10:20 Opening Session

Chair: Fabio Casciati

10:20 - 11:00 Frank Naets, Wim Desmet:

An estimation approach for uncertain parameters in multibody systems

11:30 - 12:10 Mathias Jesussek, Katrin Ellermann:

Fault detection and isolation for a railway vehicle by evaluating estimation residuals

12:10 - 12:50 Guo-Kang Er, Vai Pan Lu:

The probabilistic solution of the plate with simple-supported and stretched boundary and uniform load being Gaussian white noise

Chair: Sondipon Adhikari

14:00 - 14:40 Igor Iroz, Sergio Carvajal, Michael Hanss, Peter Eberhard:

Inverse fuzzy arithmetic for the quality assessment of substructured models

14:40 - 15:20 Tommaso Tamarozzi, Frank Naets, Wim Desmet:

Parameterized nonlinear model reduction for multibody simulation with uncertain parameters

15:50 - 16:30 Thanapat Wanichanon, Hanchaeol Cho, Firdaus E. Udawadia:

An approach to the dynamics and control of uncertain multi-body systems

18:30 - 22:00 Symposium Reception in the Marmorsaal (“Marble Hall”), Weissenburg Park, Stuttgart

#### Wednesday, June 11, 2014

Chair: Wim Desmet

9:00 - 9:40 Kheirollah Sepahvand, Khaled Nabih, Steffen Marburg:

Collocation-based stochastic modeling of uncertain geometric mistuning in bladed rotor

9:40 - 10:20 Peter Hagedorn, Manuel Eckstein, Eduard Heffel:

A note on design uncertainties in self-excited vibrations

10:20 - 11:00 Ji Yang, Beatrice Faverjon, Herwig Peters, Nicole Kessissoglou:

Application of polynomial chaos expansion and model order reduction for dynamic analysis of structures with uncertainties

11:30 - 12:10 Kheirollah Sepahvand, Sandip Kumar Saha, Vasant A. Matsagar, Steffen Marburg:

Stochastic analysis of base-isolated liquid storage tanks using lumped-model

12:10 - 12:50 Sondipon Adhikari, Hamed H. Khodaparast:

Spectral methods for fuzzy structural dynamics: Modal vs. direct approach

Chair: Carsten Proppe

14:00 - 14:40 Robert Seifried, Ali Moghadasi:

Analysis of design uncertainties in structurally optimized lightweight machines

14:40 - 15:20 Jaap P. Meijaard:

The importance of imperfections in leaf-spring flexures for the support stiffness

15:50 - 16:30 Anas Batou, Christian Soize, C. K. Choi, H. H. Yoo:

Robust design in multibody dynamics – application to vehicle ride-comfort optimization

## Thursday, June 12, 2014

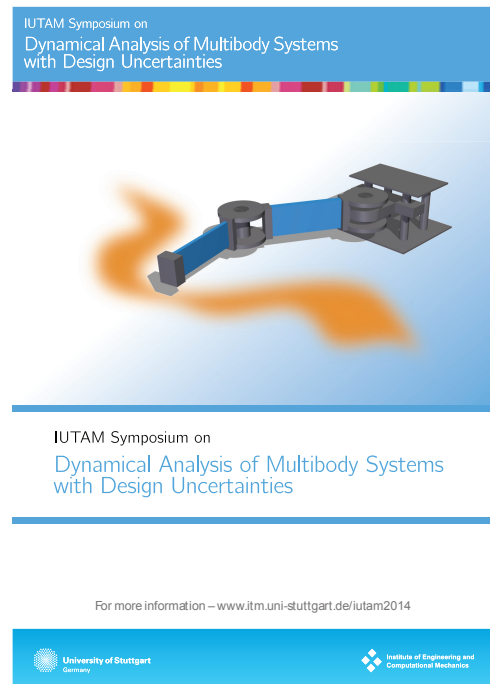
- 9:00 - 9:40 Chair: Werner Schiehlen  
Carsten Proppe, Xiaoyu Zhang:  
Influence of uncertainties on crosswind stability of vehicles
- 9:40 - 10:20 Shuxin Wang, Baiyan He, Zhiliang Wu:  
Dynamical analysis of autonomous underwater vehicles with design uncertainties: A multibody system approach
- 10:20 - 11:00 Alberto Gallina, Andreas Gibbesch, Rainer Krenn, Tadeusz Uhl, Bernd Schäfer:  
Multibody simulation of planetary rover mobility in condition of uncertain soft terrain
- 11:30 - 12:10 Nico-Philipp Walz, Markus Burkhardt, Michael Hanss, Peter Eberhard:  
Sensitivity computation for uncertain dynamical systems using high-dimensional model representation
- 12:10 - 12:50 Alexander K. Belyaev, Vladimir A. Polyanskiy, Yuri A. Yakovlev:  
Hydrogen as an indicator of high-cycle fatigue
- 14:00 - 23:00 Excursion to the Porsche Museum and the Maulbronn Monastery (UNESCO World Heritage Site)  
followed by the Conference Dinner in Markgröningen

## Friday, June 13, 2014

- Chair: Peter Eberhard
- 10:20 - 11:00 Werner Schiehlen:  
Uncertainties in road vehicle suspensions
- 11:00 - 11:40 Closing Session

The Symposium had 23 participants from the following 14 countries: Belgium, Austria, SAR Macau, Germany, Thailand, Australia, United Kingdom, Netherlands, France, China, Denmark, Poland, Russia, Italy. The scientific achievement and progress of this IUTAM Symposium was significant and substantial. Along with the demonstration of the state of the art of the potentials, challenges and limitations of different approaches to the analysis of mechanical systems in the presence of design uncertainties, the Symposium was able to highlight a variety of path-breaking prospects and powerful strategies, ranging from probabilistic methods to approaches based on interval descriptions or fuzzy sets, from linear to nonlinear problems, from forward analyses to inverse problems, and from the analysis of structures to multibody systems dynamics. Moreover, the Symposium managed to present both new theoretical developments and field-tested practical applications. The scientific articles following this preface are destined for reflecting this range of topics and shall provide an insight into the different issues addressed at the Symposium.

Last but not least, the financial support of the IUTAM Symposium by an IUTAM grant as well as additional funding by two industrial sponsors, namely the companies FunctionBay and Simpack, is gratefully acknowledged.



Michael Hanss  
Symposium Chair